

(1) Kittel 6.6

(10)

(6.34)

$$\text{Initial entropy } \bar{\sigma}_i = \bar{\sigma}_{1i} + \bar{\sigma}_{2i} = N \left(\ln \frac{n_{QA}}{n} + \frac{5}{2} \right) + N \left(\ln \frac{n_{QB}}{n} + \frac{5}{2} \right)$$

(note that $N_A = N_B$, $V_A = V_B$, so $n_A = n_B$, but in general $n_{QA} \neq n_{QB}$)

$$(1) \quad \text{So} \quad \bar{\sigma}_i = N \left(\ln \frac{n_{QA} n_{QB}}{n^2} + \frac{10}{2} \right)$$

What about the final entropy? In general, if you have a system with two non-interacting species of particles, then the state of the system is characterized by the state of one species and by the state of the other species, exactly as for the case of two separate systems. So by the same argument ($g = g_1 g_2$), we get, that

$$\bar{\sigma}_f = \bar{\sigma}_{1f} + \bar{\sigma}_{2f},$$

where $\bar{\sigma}_{jf}$ - the entropy of species #j. In our case $n_f = \frac{N}{2V} = \frac{n}{2}$, so

$$\bar{\sigma}_{jf} \stackrel{(6.34)}{=} N \left(\ln \frac{n_{Qj}}{n/2} + \frac{5}{2} \right) = N \left(\ln \left(\frac{n_{Qj}}{n} \cdot 2 \right) + \frac{5}{2} \right), \text{ so}$$

$$\bar{\sigma}_f = \bar{\sigma}_{Af} + \bar{\sigma}_{Bf} = N \left(\ln \frac{n_{QA}}{n} + \ln 2 + \ln \frac{n_{QB}}{n} + \ln 2 + \frac{10}{2} \right) \stackrel{(1)}{\Rightarrow}$$

$$\bar{\sigma}_f = \bar{\sigma}_i + (2N \ln 2) \quad \text{increas. QED} \quad (5)$$

If the atoms are identical, the expression for $\bar{\sigma}_i$ is still valid (except that now $n_{QA} = n_{QB}$). The argument for $\bar{\sigma}_f$, however, doesn't go through ($g \neq g_1 g_2$), but now we can apply (6.34) directly:

$$(2) \quad \bar{\sigma}_f = 2N \left(\ln \frac{n_q}{n} + \frac{5}{2} \right), \text{ since the total \# of particles doubles, but the concentration remains the same}$$